and an active area of less than 160 mm^2, where the active area of the display is the area of the active matrix circuit that generates an image, including all of the pixel electrodes but not including the driver electronics and the border area for bonding and sealing of the liquid crystal display. For example, the array can be at least 320×240, 640×480 or higher. A preferred embodiment of the microdisplay has an active area of 100 mm^2 or less, and is preferably in the range between 5 mm^2 and 80 mm^2. The pixel pitch for these displays is in the range of 5-30 microns and preferably in the range between 5 and 18 microns. By utilizing pixel pitches of less than 18 microns smaller high resolution displays are now possible. For an embodiment utilizing a high definition format such as 1280×1024, and utilizing a pixel pitch of 12 microns or less, the active area of the display is less than 200 mm^2.

[0015] For displays of this size and resolution to be read by a user at distances of less than 10 inches (25.4 cm) there are specific lighting and magnification requirements. For a 0.25 inch (6.35 mm) diagonal display, for example, the LED device preferably includes a plurality of LEDS coupled to a diffuser. The lens used to magnify the display image has a field of view in the range of 10-60 degrees, and preferably at least about 16 degrees-22 degrees, an ERD in the range of about 25 mm-100 mm and an object distance of between about 1.5 and 5 feet (152.4 cm). A color field sequentially operated LED backlight system can use a plurality of LEDS with a two or four sided reflector assembly to concentrate the light through the liquid crystal display. A preferred embodiment can use at least two LEDs, or as many as six or more of each color, to provide the desired brightness level. Alternatively the LEDs can be arranged around the periphery of a transmissive display and directed down into a conical reflector that directs the backlighting through the display in concentrated form.

[0016] The backlight, the display and the viewing lens can be aligned along a single axis within a small housing volume that is less than 20 cm^3, and preferably less than 12 cm^3. The system weighs less than 10 grams, preferably in the range between 5 and 8 grams. The system can be incorporated into battery operated personal communication devices without substantial alteration of their form factor and weight requirements.

[0017] While a transmissive microdisplay with a backlight is preferred, a reflective microdisplay can also be used. The light from the light source is directed onto the same side of the display that is viewed by the user. An optical system directs the reflected image from the pixel electrodes onto a line of sight of the user. Reflective displays can be used in connection with the portable communications and display systems described herein.

[0018] The display can be operated using a color sequential system as described in U.S. patent application Ser. No. 08/216,817, "Color Sequential Display Panels" filed on Mar. 23, 1994, which issued as U.S. Pat. No. 5,642,129, and of U.S. Pat. No. 5,673,059, the entire contents of these patents being incorporated herein by reference. These patents disclose an active matrix display in which the control electronics is integrated with the active matrix circuitry using single crystal silicon technology. The control electronics provides compressed video information to produce a color image for data, a still image or a video image such as a television image on the display. The use of LEDs to provide color sequential operation has a number of advantages. The system provides a lightweight, low-power light source that generates red, green and blue color components in sequence. The same control circuit operates the light source and the display to pulse the appropriate color elements for each corresponding display image.

[0019] The light source can also be pulsed for monochrome display applications. The same circuit can be used for both color sequential and monochrome systems. For monochrome operation the light source need only be flashed momentarily to provide the desired brightness level. By flashing the lamp briefly while a given frame is written on the display, the display power consumption can be substantially reduced, the voltage holding requirements of the display are reduced, and heat loading is reduced. The vertical synchronization signal can be used to trigger the light source pulse which need only extend for less than a third of the time needed to write a particular frame onto the display. Two flashes in a frame can also be used to reduce flicker.

[0020] The microdisplays described herein can be used in head mounted displays, cameras, card readers and portable communications systems, including color sequential systems as described in greater detail in U.S. application Ser. No. 08/410,124 filed on Mar. 23, 1995, the entire contents of which is incorporated herein by reference. Further details regarding the drive electronics suitable for a microdisplay can be found in U.S. Ser. No. 08/106,416 filed on Aug. 13, 1993, the entire contents of which is incorporated herein by reference. A preferred embodiment of the display control circuit utilizes an "under scanning" feature in which selected pixels are rapidly turned on and off to enhance edge definition and emulate a higher resolution display. The display control circuit can also utilize a panning capability so that a small portion of a displayed image can be selected, by mouse operation for example, and presented using the entire microdisplay image area thereby allowing the user to perceive smaller displayed features. This can also be used to view selected portions of a high resolution image, such as a portion of a 640×480 image on a 320×240 microdisplay.

[0021] As is readily apparent from the various embodiments described, one of the benefits of the microdisplay is the portability of the device using the microdisplay. An inherent concern with portability is providing enough power to operate the device for extended periods. One of the features of a preferred embodiment is the alternating of the voltage on the counterelectrode, therein allowing the microdisplay to operate at a lower voltage and therefore at a reduced power level. Another feature of a preferred embodiment is stopping the clock to the display when the display is not being written to, therein reducing power consumption.

[0022] When the display is used to display text, wherein the image display is not constantly changing, a feature of the preferred embodiment is to reduce the frame rate, or refresh rate. The reduction in frame rate results in a decrease in power consumption.

[0023] An additional problem with portability is the increased likelihood that the device will be used in non-ideal conditions. One such variable is the temperature in which the device will operate as temperature affects the performance of liquid crystal material. One of the features of a